Report on the Clinical Workstation and Clinical Data Repository Utilization at UNC Hospitals

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Abstract

On December 1, 1993, we implemented version 2.1 of the Clinical Workstation-Clinical Data Repository application in the Ambulatory Care Center. This version of the workstation allowed access of laboratory data from the clinical data repository that had been populated by a real-time HL7 interface between the Clinical Data Repository and the Laboratory Information System. This implementation completed a major part of the Clinical Workstation project. Also in December, we implemented a security system that records the date and time, user logon code, clinical workstation functions used, and the patient medical record number on whom data were displayed. In addition to the security function, this system has proven to be a valuable tool in evaluating the utilization of the clinical workstation and is the source of the data presented in this paper.

Introduction

Over the last few years the term physician workstation has appeared in the the medical informatics literature and as with many new concepts, this term has been applied loosely. Safran has suggested that these workstations must be patient centered; the interface must be uniform and data acquisition must be addressed at the system level (1). Current literature on the subject of workstations range from the theoretical (2,3) to demonstaration projects in education (4) or to limited patient care areas (5).

The large scale Clinical Workstation (CWS) project at UNC Hospitals is an effort to improve information management for healthcare providers. The Clinical Workstation and Clinical Data Repository (CDR) project began in 1991 (6). In 1993, we reported on the evolution of the CWS from the prototype to the production version 2.1 that included access to laboratory data from the CDR (7). Progress has continued and version 3 of the CWS is currently in production and version 4 is under development. Version 3 of the CWS has an icon based user interface with more consistency in displays between functions.

The CWS was designed to achieve four basic goals. The first goal was to give the physician user the illusion that the data was obtained from a single integrated information system while that system is being built over the next few years. The second goal was to make it possible for departmental information systems in the Hospital to evolve without requiring retraining of all physician users when these systems changed. The third goal was to develop a Clinical Data Repository using IBM's Relational Database Manager DB2 that would store radiology results, clinical and anatomic pathology results, discharge summaries, op-notes and clinic notes. The fourth goal was to develop HL7 interfaces between departmental systems, where this standard was supported, or locally develop Application Program to Program Communications (APPC) using the LU 6.2 standard when necessary. The

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purpose of this paper is to report the utilization of CWS/CDR in the ambulatory care setting.

Hardware, Software and Network Environment

The CWS is an IBM PS/2, model 77 with 12 mbytes of RAM running the IBM OS/2 version 2.1 operating system. Access to the UNC Hospital IBM ES9000 computer and the School of Medicine's distributed computing environment is provided via token ring network and the OS/2 Communications Manager, and TCP/IP v1.1 (IBM Corp., Armonk, NY). The CWS application is written in EASEL version 2.0 (Easel Corp., Burlington, MA) programming language with some C language communication subroutines. The Easel Workbench tool set provides a functionally rich environment for the development of the CWS. Routers (Cisco Systems, Menlo Park, CA) are used to bridge between the token ring network in the Hospital and the ethernet in the School of Medicine.

Laboratory data is transferred from the Laboratory Information System (LIS) (CHC, Houston, TX) to the CDR via an HL7 real-time interface. Radiology data (CHC, Houston, TX) and anatomic pathology data are currently moved from the radiology information system and LIS, respectively, to the CDR by daily tape transfers. This tape transfer system is temporary until the HL7 interface is completed for this text based data.

Clinic notes, operative notes and discharge summaries are transferred from the Hospital's dictation system (Softmed Systems, Bethesda, MD) via an internally developed (APPC) program using the LU 6.2 protocol. Access from the physician's office to the transcription system is provided either via the token ring network of the Hospital or the ethernet system of the School of Medicine, depending on the location of the office.

CWS Version 3 Enhancements

The major enhancements introduced in version 3 of the CWS include an icon based interface to supplement the menu bar interface that was used in version 2.1. In addition, the interface was made more uniform between the various display functions. For example, laboratory data, clinic encounters, and patient reports are all presented as cascading windows. Figure 1 below shows the initial icon based screen displayed to the user.

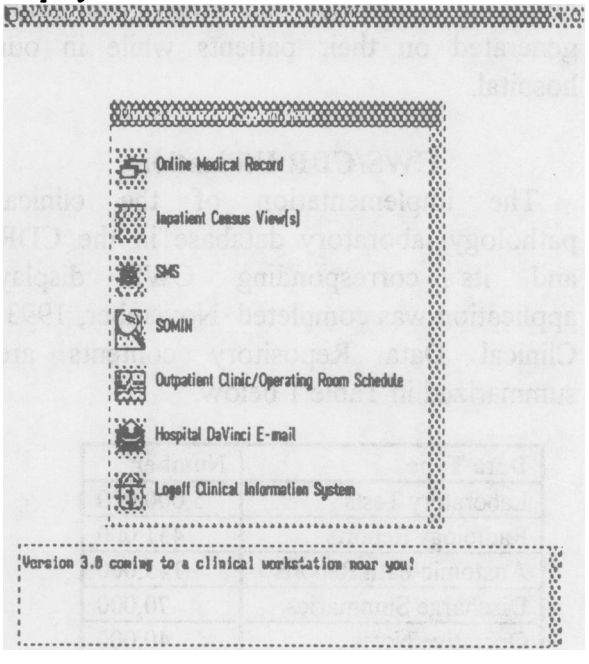

Figure 1. Initial icon based function screen.

From this screen it is possible to: use the CDR via the On-line Medical Record icon; use the inpatient view of the workstation via the Inpatient Census View icon; initiate a 3270 terminal session for SMS functions via the SMS icon; access the School of Medicine Information Network via the SOMIN icon; access the outpatient clinic and operating room scheduling system via its icon; read email via the DaVinci Email icon; and finally log off, using the log off icon. Once in the

on-line medical record system navigation is via icons for major components of the system such as general information, medications, clinic visits, laboratory data and patient reports. This increased consistency in the user interface has made it easier to navigate through the different components of the CWS application.

In addition version 3 supports the ability to print any data to network printers associated with each workstations and fax data to approved recipients via a fax server. The fax capability is expected to enhance our ability to provide referring physicians with discharge summaries and other information generated on their patients while in our hospital.

CWS/CDR Utilization

The implementation of the clinical pathology laboratory database in the CDR and its corresponding CWS display application was completed November, 1993. Clinical Data Repository contents are summarized in Table 1 below.

Data Type	Number
Laboratory Tests	5,000,000
Radiology Reports	431,000
Anatomic Path Reports	145,000
Discharge Summaries	70,000
Operative Notes	40,000
Clinic Notes	23,000

Table 1 Contents of the CDR as of 5/1/94.

The CWS clinical laboratory display application was placed in routine operation on December 1, 1993. The implementation of the laboratory display function represented the completion of a major goal in CWS/CDR project.

Also, implemented on December 1, was a security sub-system that records all user actions each time the CWS is used. The security system records the date and time of use; user name, physician identification number if a physician, CWS workstation function used and patient's medical record number. The security system has also allowed us to generate data to monitor the utilization of the CWS. The data from the security system was downloaded from the DB2 relational database in the IBM ES9000 to a PC and analyzed using Paradox for Windows version 4.5.

The major functions summarized in Table 2 below include: the total number of visits (**Visits**) in the Ambulatory Care Center (ACC) where the majority of the forty-eight CWS are installed; Select Patient function (**Sel Pt**) that must be used each time patient data is displayed; Laboratory Display Folder (**Lab**) that must be used each time laboratory data is displayed; display of physician outpatient appointments (**Appts**); display of patient medications (**Meds**); display of discharge summary reports (**DCS Rept**); display of radiology text reports (**Rad Rept**); and the display of operative notes (**Op Note**).

The number of patient records accessed via the CWS has climbed from 1,948 in December to 4,104 in April. This represents a 211% increase in use of the CWS in five months. The number of requests for laboratory data has grown from 690 or 35% of the patients selected in December to 2,460 or 60% of the patients selected in April. The increase in laboratory data display is most likely related to increased data in the CDR. Approximately, 25,000 results are transferred per day from the LIS to the CDR. Further, it should be noted that a major increase in workstation utilization (123%) occurred between March and April. The increase utilization between March and April was not due to increased patient volume in the ACC since in this interval the number of clinic visits decreased from 14,130 in March to 11,310 in April. During the month of March 1994, version 3 of the

CWS with the new icon based interface was installed in the ACC. It is possible that the increase in utilization of the CWS that occurred between March and April is due in part because of improved user interface.

Function	Dec	Jan	Feb	Mar	Apr
Visits x 10^{-1}	1077	1148	1184	1413	1131
Sel Pt	1948	2524	2131	3319	4104
Lab	690	885	810	1701	2460
Appts	270	345	243	406	352
Meds	268	262	234	394	490
DCS Rept	167	240	132	219	276
Rad Rept	114	185	239	302	426
Op Note	39	33	45	58	79
Somin	180	208	175	97	125

Table 2 Summary of frequency of use of the major CWS functions and monthly patient visits in the ACC.

In addition to growth in utilization of laboratory data, access to Radiology reports grew from 114 in December to 426 in April or a 373 % increase in utilization. Access to information on medications grew from 268 in December to 490 in April or a 183 % increase in utilization. The SOMIN system is principally used to access the local MedLine database that covers the medical literature from 1985 to the present and is maintained by the Office of Information System in the School of Medicine and Health Science Library.

The data from the security system also allowed us to determine who was using the CWS. All physicians at UNC Hospitals are assigned a unique five digit identification number that is recorded in the security system database. Non-physicians have no such number and zero is placed in the physician number field in the security system database. Based on the physician number field it is very easy to separate the physicians from the non-physician users. Non-physicians users of the CWS include nursing staff, medical students, pharmacy staff, medical secretaries, etc. The users of the CWS are shown in Table 3 above.

User	Dec	Jan	Feb	Mar	Apr
Physicians	88	89	87	109	123
Staff	26	41	48	61	49
Total	114	130	135	170	172

Table 3 Shows the number of Physician and non-physician users of the CWS between December 1993 and April 1994.

From the data in Table 3 it is apparent that the number of physician users has increased from 88 in December, to 123 in April, representing an increase of 140%. The greatest increase in physician use occurred in the months of March and April. Again, the increase in physician use between March and April can not be explained by increase in patient volume since patient volume in the ACC actually decreased in this interval. It is possible that this increase in use was related to the improved user interface. Non-physician staff use was less predictable but could have possibly decreased because of greater use of the CWS by the physicians themselves.

Phy Users	Dec	Jan	Feb	Mar	Apr
Med Fac	29	32	32	37	40
Surg Fac	9	7	7	8	6
Other Fac	10	10	9	10	14
Fac Total	48	49	48	55	60
Med HS	25	23	27	29	30
Surg HS	3	2	1	6	8
Other HS	12	15	11	19	25
HS Total	40	40	39	54	63

Table 4 CWS physician users by medical specialty and position on faculty (Fac) or House Staff (HS).

Although the total number of physician users were small it was possible to break physician user down by medical specialty. Table 4 above shows a distribution of physician users by specialty. As might be expected the top two users of the CWS were internal medicine and surgery. The other medical specialties

group was comprised of pediatrics, dermatology, family medicine, emergency medicine, radiation oncology, ob/gyn, and orthopedics. The data shows a progressive increase in CWS utilization in both Faculty and House Staff and that both groups appear to be equal users of the CWS at the present time.

Future CWS/CDR Enhancements

The next major advance in the CWS/CDR project will occur in July, 1994, when one hundred fifty-five Clinical Workstations will become operational on the inpatient services of UNC Hospitals. The major display interface will be the same as in the outpatient version but the user will enter the inpatient application via the Inpatient Census View icon shown in Figure 1. The implementation of the CWS in the inpatient environment will give UNC Hospitals a uniform method for the display of patient care data for all health care providers in the Hospital. In addition to the inpatient system a remote dial-in version of the CWS has been completed and is being field tested by a group of physicians on the CWS development team.

Currently, the SMS order entry system is being installed at UNC Hospitals. This order entry system will provide the transaction processing system for the order module of the CWS that is planned for version 4. Future work will concentrate on creating data structures that will support acquiring data directly from the physician-patient encounter. Such structured data will allow the creation of an order entry function for the CWS that will support direct physician use and provide medical alerts based on institutional patient care rules.

Much has been accomplished at UNC Hospitals in a relatively short period of time but clearly, the next phase of the CWS/CDR development will be the most critical for achieving maximum utility of this information system. We will continue to use the data from the security system to monitor use of the CWS/CDR and, upon completion of the inpatient version, develop tools for monitoring user satisfaction with the information system.

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